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Technical Lesson 31

REGENERATIVE DETECTOR WITH CAPACITIVE CONTROL OF FEED-BACK

The method of controlling regeneration described in the preceding lesson is considered to be one of the best, for it is smooth and even in operation and, in addition, it possesses the advantage of having very little tuning effect upon the wavelength adjustment of the grid circuit. Another method, equally as good and also employing capacitive control of regeneration, will be described in this lesson. The circuit of the receiver now being dealt with and the circuit of the preceding lesson are quite similar. Comparison later will show that while the circuits themselves vary but slightly, yet there is absolutely no difference in the arrangement of the parts that form the circuits. This lesson will serve to illustrate how identical principles may be used to obtain certain results, but that the method of applying such principles can be varied, and how this necessitates only a slight alteration in circuit arrangement.

In the receiver described in this lesson, regeneration is secured by means of inductive coupling between the plate and grid circuits of the detector tube through the use of the usual tickler coil. This tickler coil can remain fixed in its position and feed-back controlled by varying the strength of the radio-frequency component of the plate current flowing through it — a variable condenser being used to secure this control of the radio-frequency current.

This, in its fundamental principle, is the same method of securing and controlling regeneration as was employed in the receiver of the preceding lesson. The actual difference in the circuit arrangements of both receivers can be most clearly understood by a comparison of Figure 1 in this lesson with the schematic wiring diagram in Figure 1 of Lesson 30.

An examination of these two diagrams shows that the difference between them exists in the plate-tickler sections of the circuits. In the circuit of the preceding lesson the currents in the plate circuit are separated at the plate, the radio-frequency component flowing through the tickler coil and feed-back control condenser while the audio-frequency component flows through the radio-frequency choke coil and headphones.

In the circuit of this lesson the radio-frequency and audio-frequency components of the plate current both flow through the tickler coil and are then separated at point X in Figure 1. At this point the plate circuit divides into two branches and, due to the electrical dimensions of these two branches, the audio and radio-frequency components of the plate current are caused to separate in exactly the same manner, and in accordance with the same reasons, as already explained in the preceding lesson.

The audio-frequency component of the plate current will flow through the radio-frequency choke coil and headphones to the filament circuit as these instruments offer less reactance to audio-frequency currents than the variable condenser FC. On the other hand, the radio-frequency component of the plate current will flow through condenser FC to filament as the capacitive reactance of this condenser is much less to radio-frequency currents than the inductive reactance of the radio-frequency choke coil. Thus, the radio-frequency choke coil serves the same purpose here as it did in the preceding lesson, that is, it prevents the radio-frequency component from being short-circuited, or by-passed, by the distributed capacity of the headphones or transformer primary depending upon which one is inserted in the plate circuit of the detector. The distributed capacity of the windings of either the phones or transformer primary is indicated by the imaginary condenser C_x drawn in dotted lines in Figure 1.

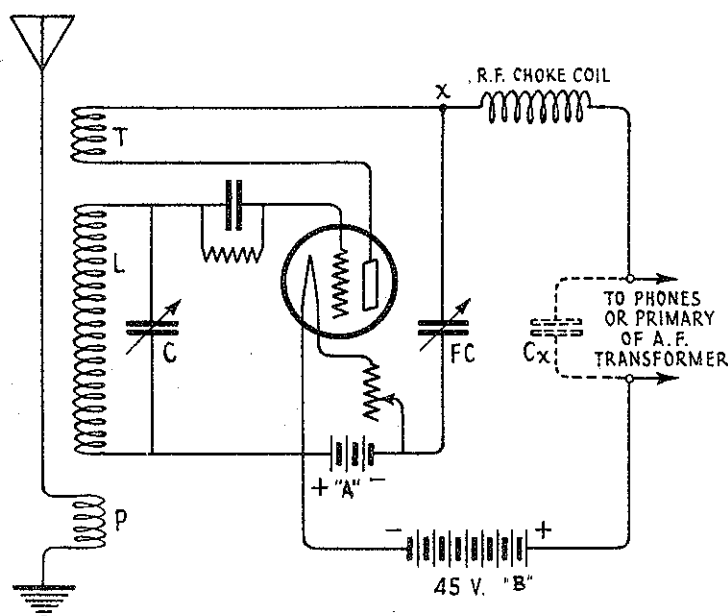


Figure 1

By varying the capacity of condenser FC, its reactance to the flow of radio-frequency current is changed and it is this variation in the strength of the radio-frequency current that provides us with a means of controlling feed-back energy. A condenser used for this purpose is often termed a "throttle" condenser, presumably because it serves to throttle down the flow of radio-frequency current through the tickler coil—the degree to which it throttles the radio-frequency current determining the amount of plate to grid feed-back.

Both of these circuits are technically called "regenerative detectors with capacitive control of feed-back". Furthermore, one circuit differs from the other not only by the circuit variation as outlined above, but also by the fact that one is "shunt feed" while the other is "series feed".

The terms "shunt feed" and "series feed" refer to the manner in which the tickler coil is placed with respect to the source of plate potential which

in this instance is the "B" battery. The "B" battery "feeds" potential to the plate of the tube and a glance at the schematic wiring diagram of Lesson 30 will disclose that the tickler coil circuit is in shunt, or parallel, to the "B" battery, and hence, from this arrangement arises the term "shunt feed". This time by referring to Figure 1 of this lesson, it will be seen that here the tickler coil is in series with the "B" battery and, therefore, this arrangement is given the name "series feed".

It should be understood that in this receiver, the path of the radio-frequency component of the plate current is through the tickler coil and condenser FC to filament, and that the principal factor limiting the flow of radio-frequency current through this path is due to the capacitive reactance of the condenser. Any change in the capacity of this condenser will vary the strength of the radio-frequency current flowing through the tickler coil, thus providing us with a means of controlling feed-back as we have already mentioned.

To be more specific, an increase in the capacity of condenser FC decreases its reactance and, since this results in an increase in the strength of the radio-frequency current flowing through the tickler coil, the effect is to produce an increase in feed-back. Conversely, a decrease in the capacity of this condenser increases its reactance and thereby decreases feed-back due to the corresponding decrease in the strength of the radio-frequency current flowing through the tickler coil.

The student can easily see what changes are necessary in the connections of the regenerative receiver of the kind described to convert it from the hook-up of Lesson 30 to the circuit shown in Figure 1 of this lesson. The changes are entirely in the plate circuit of the detector tube, and a study of the schematic wiring diagram of this lesson and the one in Lesson 30 will quickly show the difference in the plate circuit connections.

In the following paragraphs are given the principal differences in arrangement between the regenerative circuit described in Figure 1 of Lesson 30, and the regenerative circuit treated in this lesson as shown in Figure 1. The primary terminals of the three-circuit tuner connect to the antenna and ground binding posts. The +A binding post on the terminal strip connects to the + filament terminal of the tube socket. The -A binding post on the terminal strip is connected to one terminal of the detector filament rheostat, while the other terminal of this rheostat is attached to the - filament terminal of the tube socket. Notice how the tuning condenser is arranged in parallel with the secondary of the three-circuit tuner, and particularly how the rotor plates of the condenser are attached to the end of the secondary which is nearest the antenna coil, and the stator plates to the end of the secondary which is farthest from the antenna coil. The end of the secondary coil nearest the antenna coil is connected to the + filament line, while the other terminal of the secondary is connected to the grid condenser. The remaining terminal of the grid condenser is connected to the grid terminal of the tube socket. In this way the rotor plates of the condenser connect to the "low" end of the tuner secondary while the "high" end of this same coil connects to the stator plates and to the grid of the tube. The plate terminal of the tube socket connects to one of the tickler coil terminals, and the remaining terminal of this coil connects to the stator plates of the "throttle" condenser. The rotor plates of this condenser connect to the filament circuit. A

connection is made from the stator plates of the "throttle" condenser (to which one terminal of the tickler coil is also connected) to the radio-frequency choke coil. The remaining terminal of the r-f choke is connected to one of the tip-jacks. The other tip-jack is connected to the Det + B binding post on the terminal strip. These connections would go to the tip-jacks only if the headphones were to be used in the plate circuit of the detector tube. If the audio-frequency amplifier were to be used instead of the phones, connection from the r-f choke coil to the tip-jack would be disconnected from the tip-jack and this connection would go to the P terminal of the first stage audio-frequency transformer. The connection from the Det + B terminal would be disconnected from the remaining tip-jack and connected instead to the B terminal of the a-f transformer. It is general practice to employ one a-f stage with power detection and otherwise two stages.

In the preceding lessons mention has been made of the "high" and "low" ends of the secondary coil of the tuner. The terms "high" and "low" are used to indicate the distribution of radio-frequency potential along the secondary coil.

For example, the end of the secondary coil to which the antenna coil is coupled, and which is also connected to the filament circuit, is the end of the coil which is at the lowest radio-frequency potential. As the radio-frequency voltages at this point are so small as to be negligible, this end of the secondary is termed the "low" end.

On the other hand, the remaining terminal of the secondary coil, that is, the end of the secondary farthest removed from the filament end, is the point at which the highest available radio-frequency voltages are encountered and this terminal is therefore referred to as the "high" end of the secondary.

Try to keep in mind the terms "high" and "low" used in the manner just explained and you will realize why it is always necessary to specify to which end of the secondary coil the grid of the tube should be connected. Let us repeat that the terminal of the coil at which the highest radio-frequency voltage is developed should always be connected to the grid of the tube inasmuch as the vacuum tube is a voltage operated device.

Perhaps you have noticed while studying preceding lessons that it has been mentioned that the rotor plates of a tuning condenser should always connect to that end of the secondary which connects to the filament, or the "low" end and, that the stator plates should connect to that end of the secondary farthest from the filament end, or the "high" end. This is necessary in order to avoid what is known as the "body capacity" effect.

If the hand is brought near the tuning instruments of an oscillatory circuit, the circuit will be thrown out of resonance with the frequency to which it was tuned, and this phenomenon is usually attributed to the assumption that the human body is capable of acting as an electrostatic condenser. Hence, placing the hand in close proximity to portions of a radio-frequency circuit has the same effect as though the capacity of the tuning condenser associated with the circuit had been changed. In other words, when an operator is in the act of tuning and his hand is moved near to, or away from, the circuit, the tuning will be altered in quite the same manner as though the capacity of the tuning condenser itself had been varied.

This so-called "body capacity" effect is most pronounced at those portions of the circuit at which are encountered the highest radio-frequency potentials, and, therefore, as far as the secondary coil of this circuit is concerned, such an effect is most noticeable at the "high" end of the secondary. This is an important factor insofar as it has a definite bearing upon how the tuning condenser should be connected to the secondary coil.

The "body" capacity acts on the receiving circuit because the tuning condenser being mounted upon the panel has its shaft connected directly to the rotor plates, and this shaft projects through the panel and upon this shaft a dial is mounted so that when grasping the knob of the dial with the fingers it brings the hand near the metal shaft of the condenser. Since only the thickness of the insulating knob then separates the fingers from the metal shaft, yet this is near enough to cause trouble if the rotor plates, which are attached to the shaft, are connected to a point in the circuit which is operating at an appreciable value of radio-frequency potential.

If the rotor plates of a tuning condenser were improperly connected to the "high" end of the secondary coil, body capacity effect will be experienced and, as stated above, it always acts to change the tuning of the circuit whenever the hand is brought near, or moved away from, that part of the circuit which is operating at an appreciable value of radio-frequency voltage. In this instance, the effect is carried to the shaft of the tuning condenser. In actual operation of a receiver this effect makes itself evident in the following manner: The hand is placed on the knob and a station tuned in. Then when the hand is removed from the knob the tuning of the circuit is changed due to the removal of the "body capacity" of the hand, and the station which was then being received immediately decreases in strength or disappears entirely. Placing the hand again on the dial restores the tuning of the circuit and the station is again received at its former signal strength.

The effect of body capacity introduced into the circuit under such circumstance is very troublesome and, should it exist to a pronounced degree, makes accurate tuning impossible.

To eliminate this bothersome condition the rotor plates of a tuning condenser should always be connected to the point of lowest radio-frequency potential, that is, to the filament or ground circuits. This will place the rotor plates and shaft at practically zero radio-frequency potential and thereby do away with body capacity and its consequent de-tuning effect.

This rule to always connect the rotor plates of a variable condenser to the point of lowest radio-frequency potential wherever it is possible to do so applies to all variable condensers. Whether the condenser is being used as a tuning condenser or whether it is being used for other purposes than tuning, it is common practice in the design of receiving sets to connect rotor plates in accordance with these suggestions.

For instance, in Figure 1, are shown two variable condensers, one being a tuning condenser while the other is a "throttle", or feed-back control condenser. This diagram clearly shows that one set of plates of each of these condensers, namely the rotor plates, connect to the filament circuit. It should now be clear that in order to avoid body capacity effect while making tuning and feed-back adjustments all variable type condensers should be

connected to either the filament circuit or to any other low potential portion of the receiver circuit.

On the other hand, the stator plates are the ones which connect to the point of high radio-frequency potential, which in the case of the tuning condenser is the "high" end of the secondary coil while in the case of the throttle condenser this connection is to the tickler coil. The stator plates when so connected are not subject to the effect of body capacity because the hand is not brought sufficiently close to them during the manipulation of the control dials.

EXAMINATION - LESSON 31

1. What is the purpose of the throttle condenser?
2. How does it accomplish its purpose?
3. What is meant by the "high" end of the tuning coil?
4. What is meant by the "low" end of the tuning coil?
5. What is body capacity effect?
6. Is its presence desirable in a receiver?
7. Why is the grid of the tube connected to the "high" end of the tuner secondary?
8. What kind of regeneration control is used in this receiver?
9. How is regeneration obtained in this circuit? Explain fully.
10. Why are the rotor plates of the tuning condenser connected to the "low" end of the tuner secondary?